EPIC SYMPOSIUM

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EPIC SYMPOSIUM

Survival Tips for Entrepreneurs

Moderator: **Dr. Danielle Applestone**

Presenters: **Dr. Gregory Poilasne**, **Kristin Sampayan**, **Tim Latimer**, **Leila Madrone**, **Dr. Kristin Denault**

EPIC SYMPOSIUM

Lunch Session is Currently in Progress

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EPIC SYMPOSIUM

Broadening Storage Technologies Beyond Lithium-Ion

Moderator: **Edward Randolph**

Presenters: **Laurence Abcede, Richard Wirz**, **Philippe Bouchard**, **Rick Winter**, **Byron Washom**

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2019 EPIC Symposium
Broadening Storage Technologies Beyond Lithium Ion

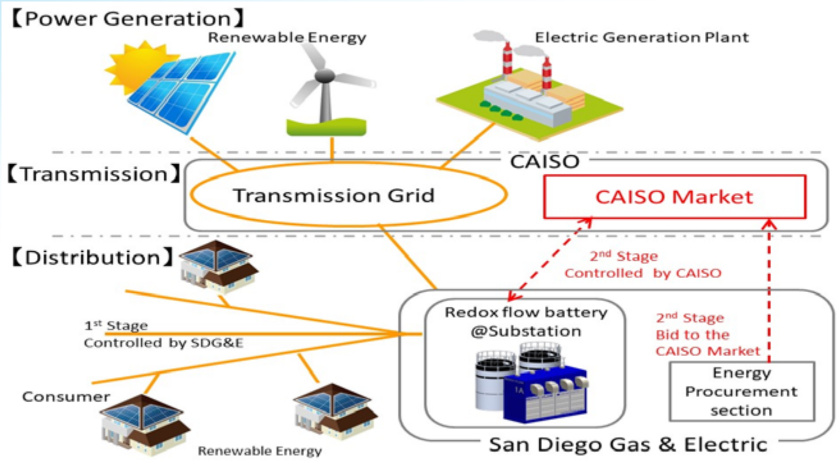
Vanadium Redox Flow Battery Demonstration at San Diego Gas & Electric Company

Laurence Abcede
Distributed Energy Resources

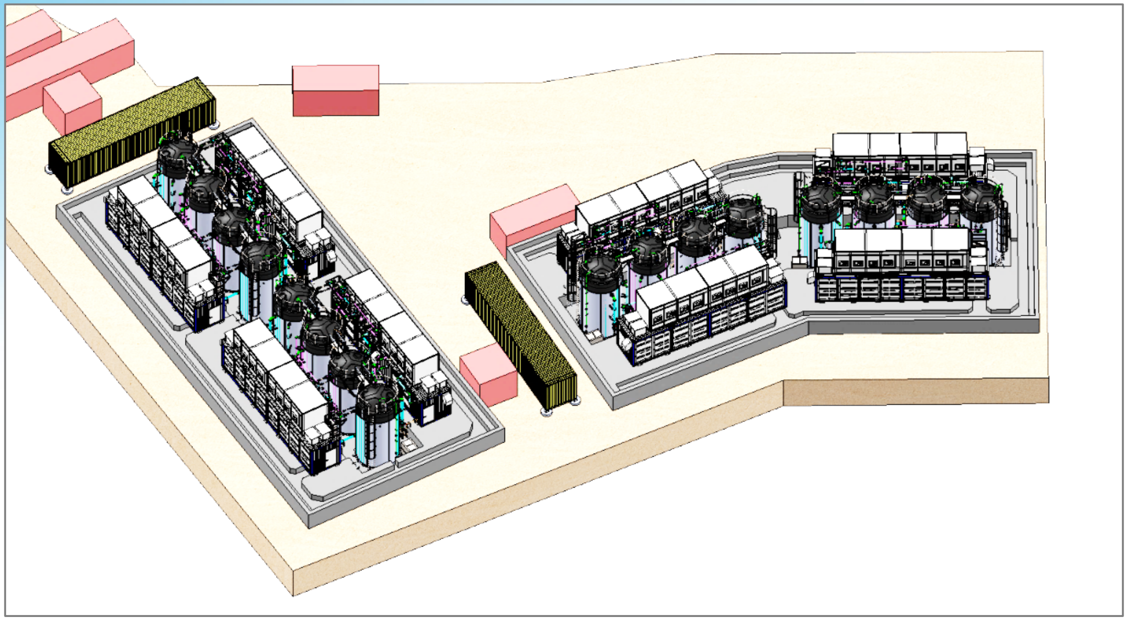
February 19, 2019

SDG&E / SEI VRF History

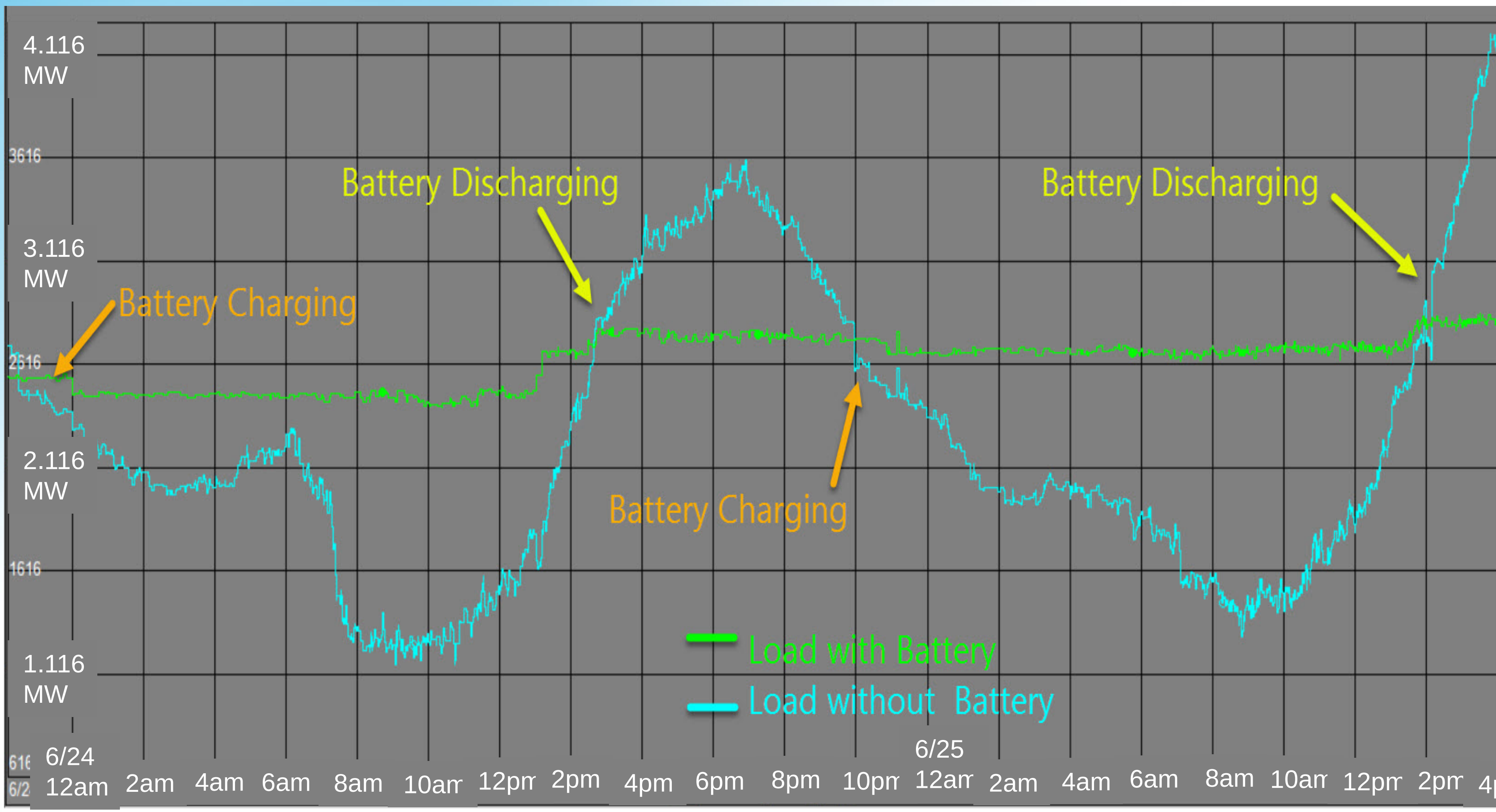
- The New Energy and Industrial Technology Development Organization (NEDO) and Sumitomo Electric (SEI), sought a California IOU partner for a United States demonstration project
- Provide a full-scale system, between 2-8 MW, to support any use case determined by the IOU
- SDG&E was chosen as the IOU member to partner with SEI.
- Miguel Substation in Bonita, CA was chosen as the most suitable location
- SEI and SDG&E signed an agreement on April 2016
- The VRF Battery was commissioned and fully operational on June 2017
- The VRF Battery is participating in the CAISO marketplace as of December 2018



Miguel Vanadium Redox Flow Battery Installation



Example of Operation



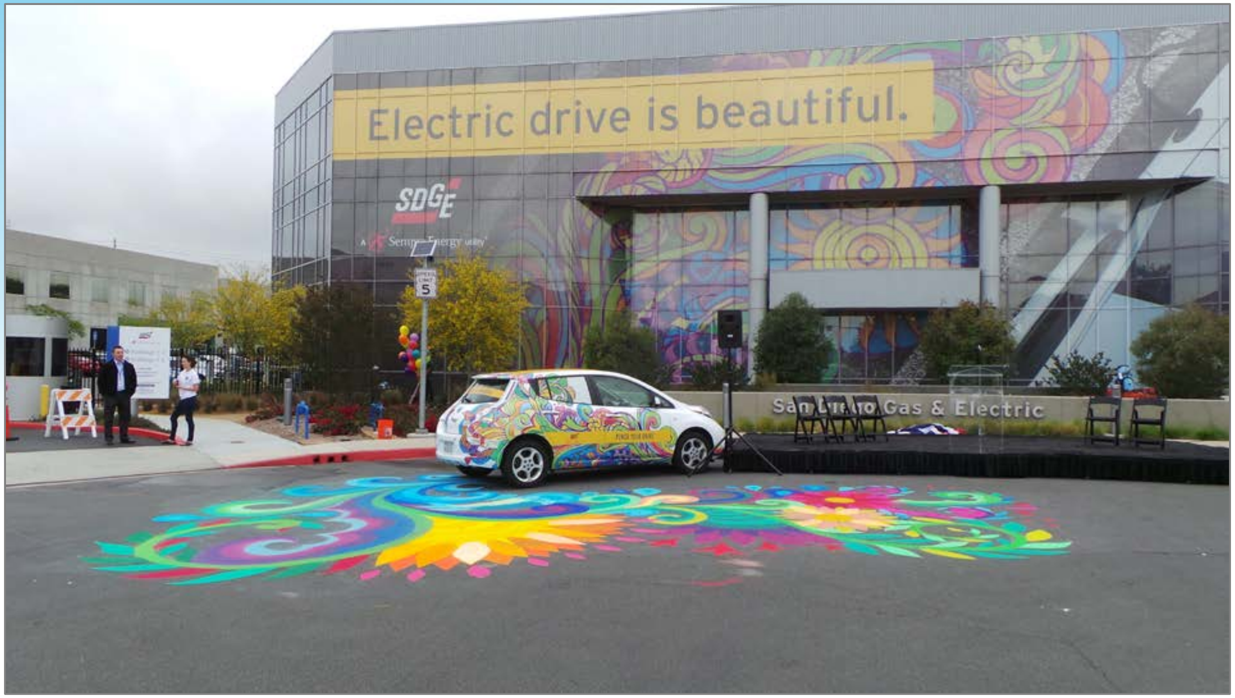
Summary of Lessons Learned

Needs
- Multi-Purpose Asset
- Mitigate intermittency of PV
- Store excess renewables
- Ramp support

Demonstrate
- Limitless Cycles
- Long Lifetime
- Use of High Power PCS
- Efficiency Enhancement

Use Case Drives Technology Choice
- Power vs. energy
- Technology cost
- Technology safety

Questions?



Thank You

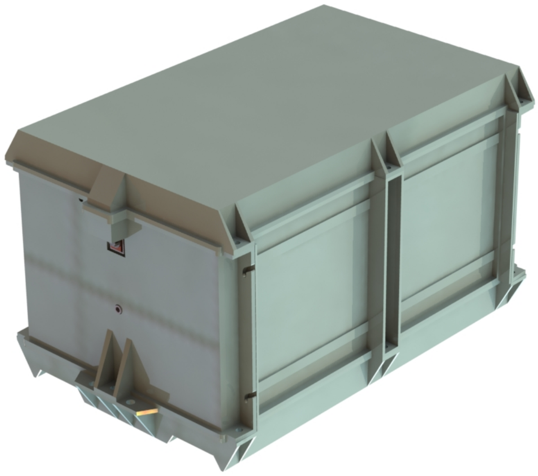
Laurence Abcede
SDG&E DER Manager
labcede@semprautilities.com

Eos Energy Storage

Confidential & Proprietary

Znyth® Battery Specification

Design 132



Characteristic	Units	Parameter
Nominal Voltage	V_{DC}	64
Voltage Range	V_{DC}	44 to 82
Rated Power	kW	0.5
Rated Energy	kWh	2.0
Nominal Discharge Current	A_{DC}	8.0
Maximum Current	A_{DC}	22
Short Circuit Current	A_{DC}	350 maximum
Short Circuit Time Constant (L/R)		< 5ms
Round Trip DC Efficiency	%	Approximately 75 at 100% DoD
Self-Discharge	Whr/hr	25
UL Rating		UL 1973 (pending)
Optimum Operating Temperature (Ambient)	°C	10 to 45
Maximum Operating Temperature (Ambient)	°C	-20 to 55
Dimensions (H x W x D)	in. (cm)	15.36 x 17.05 x 27.41 (39.0 x 43.3 x 69.6)
Weight	Lbs (kg)	~275 (125)

Table 1: Summary of the Znyth Battery Gen 2.0 Beta (CID 132)

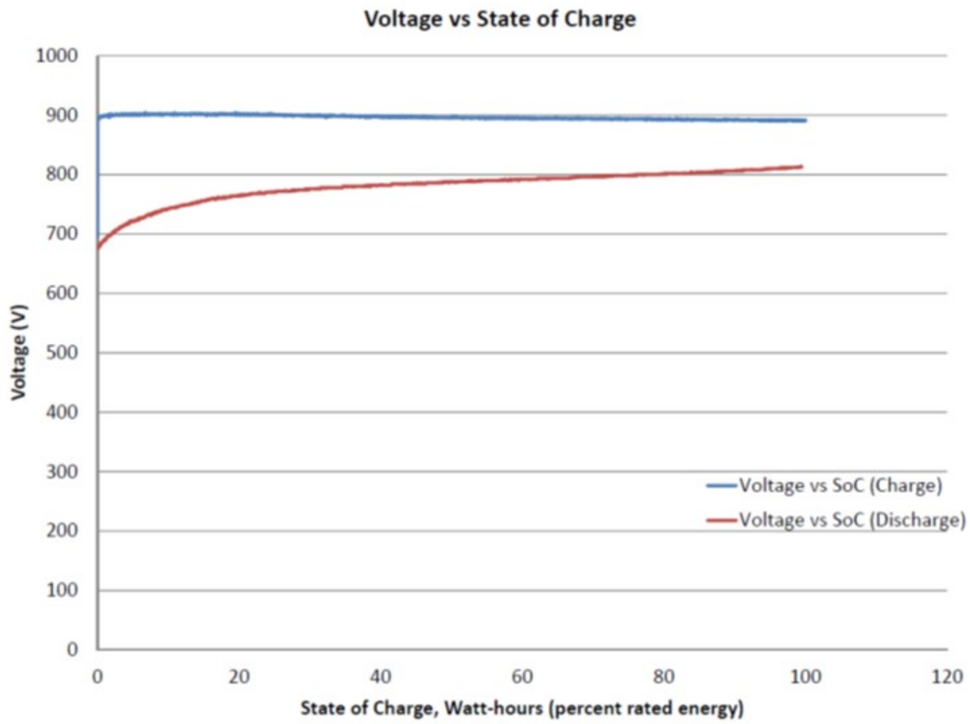
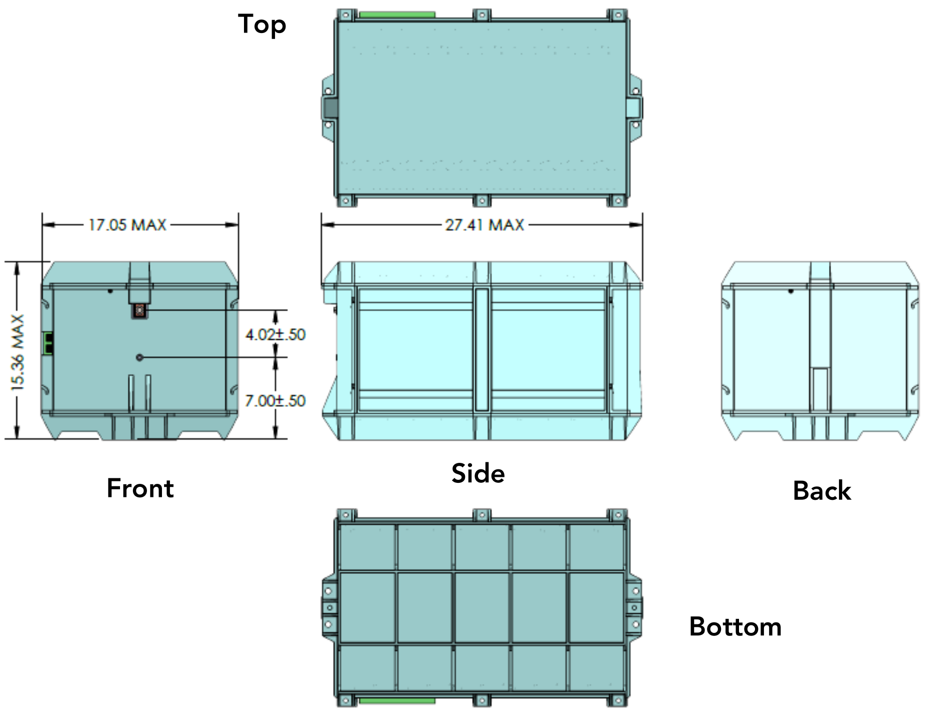
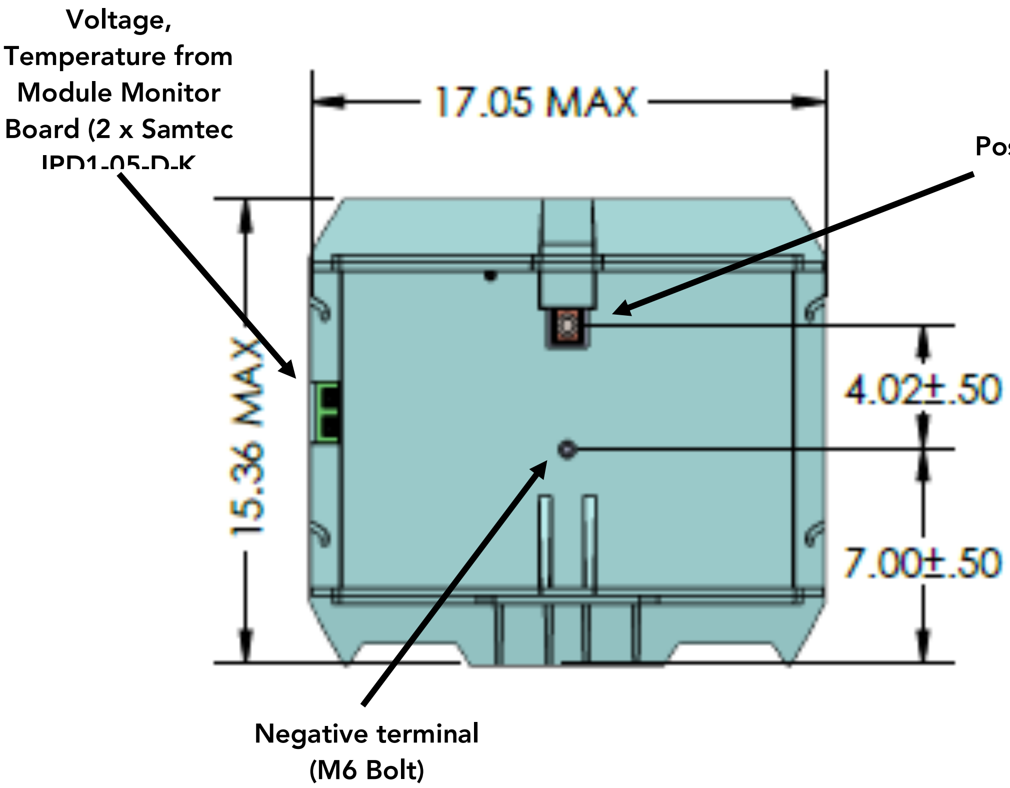


Figure1: Charge/Discharge VDC vs. SOC (@C/4 Charge/Discharge Rate)



View 1: Battery Drawings (dimensions in

inches)



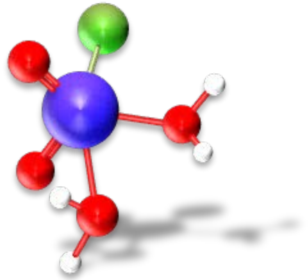
View 2: Front panel with terminals and connection ports

(dimensions are in inches)

UniEnergy Technologies

Rick Winter, CEO

Commercializing High Performance Vanadium Flow Batteries



10MW/40MWh on 15,000ft^2

2012, 2013, 2014
- IP DEVELOPMENT
- Electrochemical, Mechanical, Power & Controls Engineering

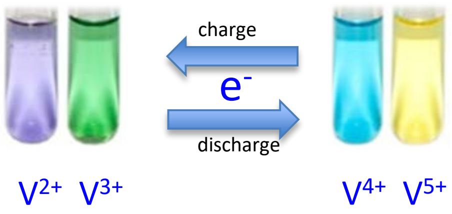
2015, 2016, 2017
- PRICELESS FIELD EXPERIENCE
- Understanding Customers
- Contract Manufacturing

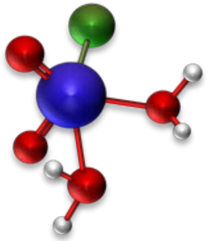
2018
- PIVOT TO **REFLEX™**
- Customer Driven Design
- Flexible, Modular, Resilient

2019
- 100kW C&I PROJECTS
  - High System Availability
  - Industrial Design

2020
- ELECTRICITY WAREHOUSING
- E'lyte Leasing
- Storage-as-a-Service

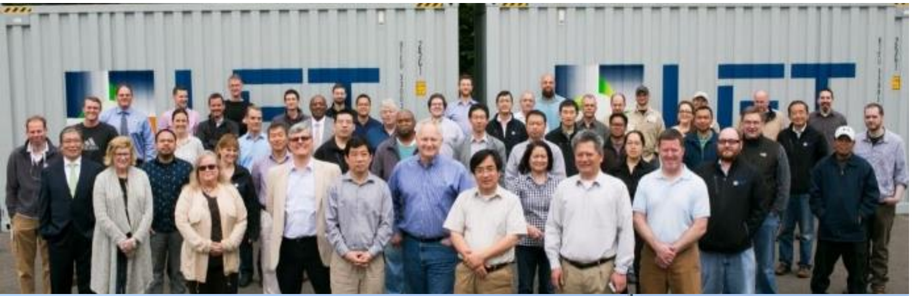
UET + RKP + BNM + US DOE + DICP + 32 Utility and C&I Customers = ReFlex™





$VO_2Cl(H_2O)_2$

U.S. DEPARTMENT OF ENERGY



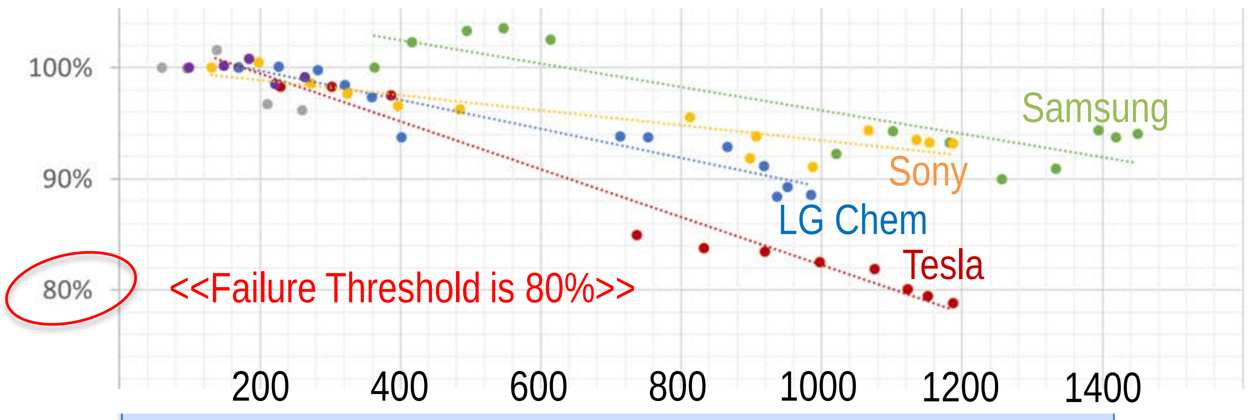
$500MM collaboration over 15 years to deliver the most resilient, safe and cost-effective battery for bulk electricity storage

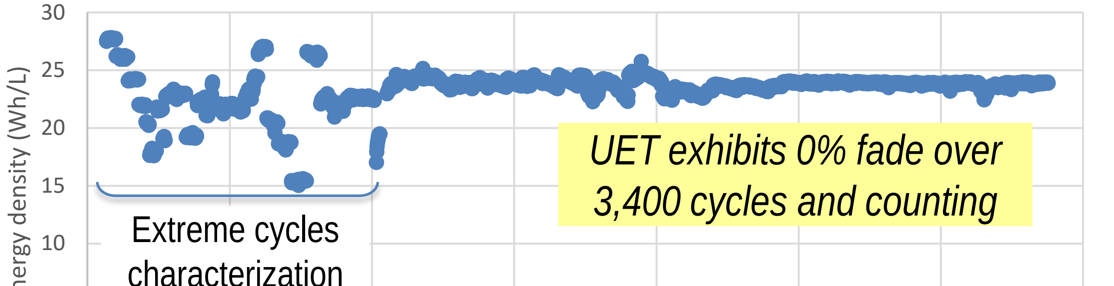
4MWh containerized system

40MWh on 3 basketball courts

UET's no-fade performance is a strong advantage over leading lithium technologies that degrade 15-20% over 12 months

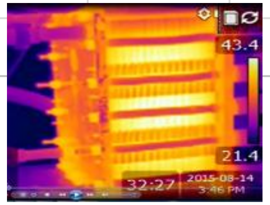
Source: http://batterytestcentre.com.au/wp-content/uploads/2017/07/Battery-Testing-Report-4-March-2018.pdf





1400 Cycles

1400 Cycles

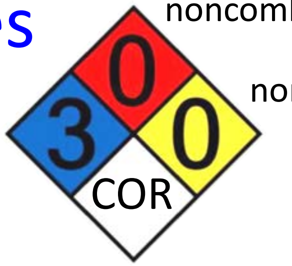


Full scale stack under short circuit testing

- All state-of-the-art lithium batteries are exhibiting precipitous capacity fade after only 12 months of testing
- Tests are performed within manufacturers recommended SOC limits and including obligatory rest periods between charging and discharging
- Lithium batteries are typically deemed to have failed at 80% capacity due to accelerating decay mechanisms

- UET's vanadium flow batteries do not exhibit any capacity fade over >3400 cycles to 100% DOD with no rest periods between cycles
- This performance stability substantially eliminates operational risks when deploying large scale electricity storage plants

Compelling Safety of Flow Batteries



noncombustible

nonreactive

- Aqueous electrolytes that comprise most flow batteries are non-flammable and non-reactive with water
- Stopping the pumps switches off the chemical reaction
- Stranded energy in the stacks is insufficient to cause re-ignition hazards or arc flash
- Electrolyte and other materials are not a fuel source, but may release hazardous materials when exposed to a sustained external fire

Lithium Batteries

1. FIRES: More than 20 Lithium Battery Fires >1MWh in the last year

2. EXPLOSIVE RE-IGNITION
Three experienced firefighters were severely burned *after* this 2.5MWh lithium fire was contained

3. TOXIC FUMES: this lithium battery with state-of-the-art fire protection failed during commissioning, closing freeways and evacuating citizens

EPIC
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Networking Break
and
Poster Session

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EPIC SYMPOSIUM

Non-Battery Solutions for Grid Flexibility

Moderator: **Matthew Tisdale**

Presenters: **Tom Tansy**, **Dr. Ajit Renjit**, **Dr. Edward Cazalet**

Flexibility Enabled by Rule 21 Ph 3 Functions

Update on CEC 16-079 Grp 4

Ajit A Renjit, PhD
Technical Lead – DERMS & Microgrid Controls
CEC EPIC Symposium 2019
02/20/2019

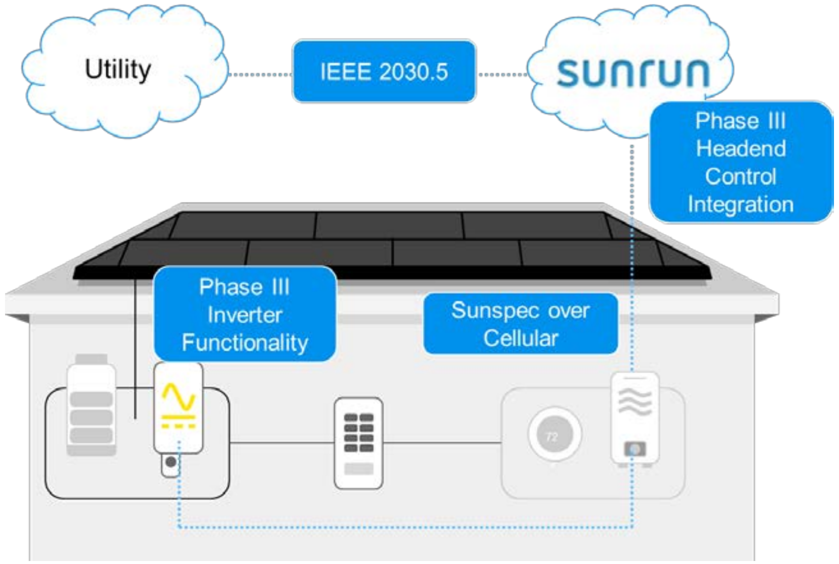
ELECTRIC POWER RESEARCH INSTITUTE

CA Rule 21 Phase 3 Functions

No.	Function Name
1	Monitor Key DER data
2	DER Cease to Energize and Return to Service Command
3	Limit Maximum Active Power Mode
4	Set Active Power Mode
5	Frequency-Watt Mode
6	Volt-Watt Mode
7	Dynamic Reactive Current Support
8	Scheduling Power values and Modes – Volt/VAR, Power Factor and Volt/Watt

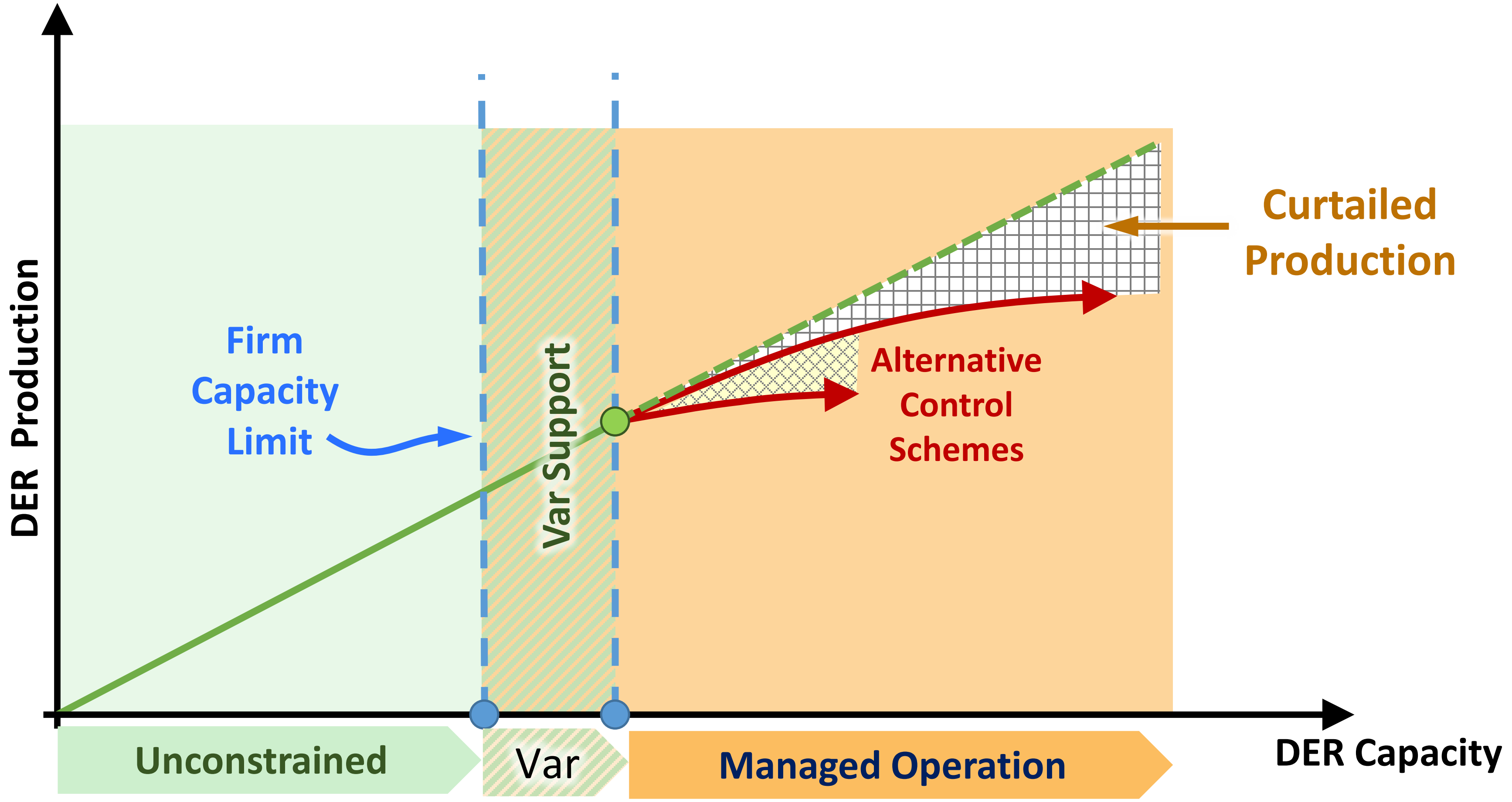
Project Plan:

- Feeder Modeling and Economic Assessment of Phase III Functions
- Implementation of Phase III Functions
- Develop Compliance Test Procedures
- Laboratory and Field Evaluation
- Cyber Security Testing and Public Key Infrastructure



Flexibility Enabled by Rule 21 Ph 3 Functions

*Ph 3 Functions when **managed** (DERMS) enables **more DER capacity to interconnect** by managing **real-power** output of DER to stay within **grid-level constraints**.*



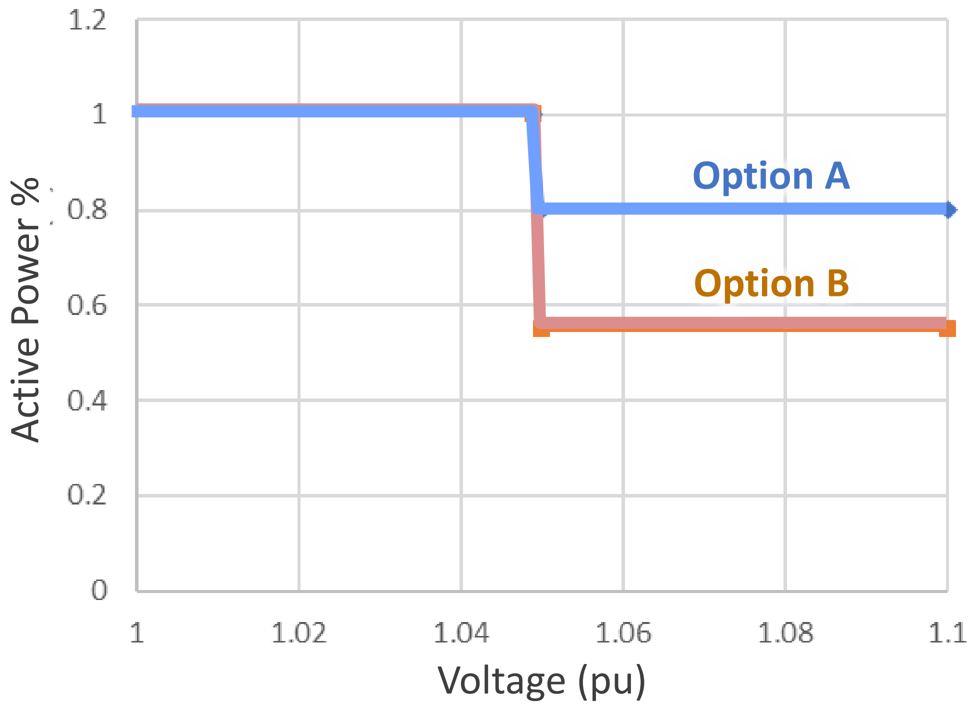
Flexibility Enabled by Rule 21 Ph 3 Functions

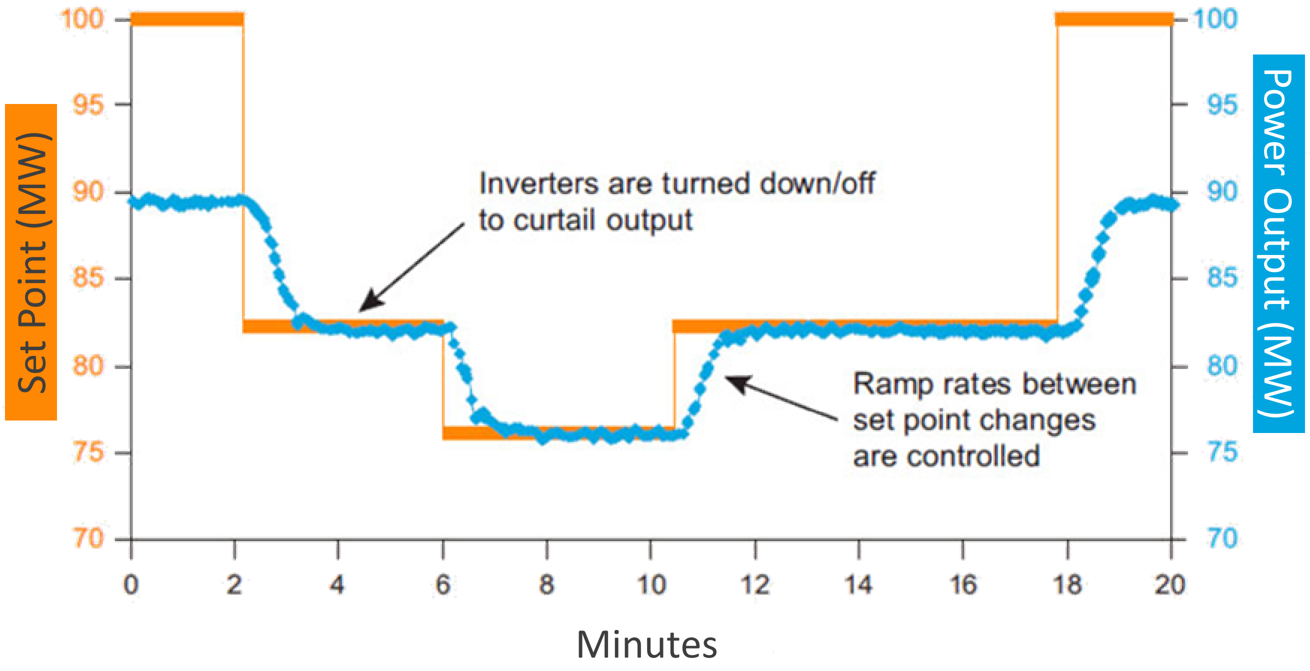
Autonomous Control

Rule 21 Ph 3

Managed Control

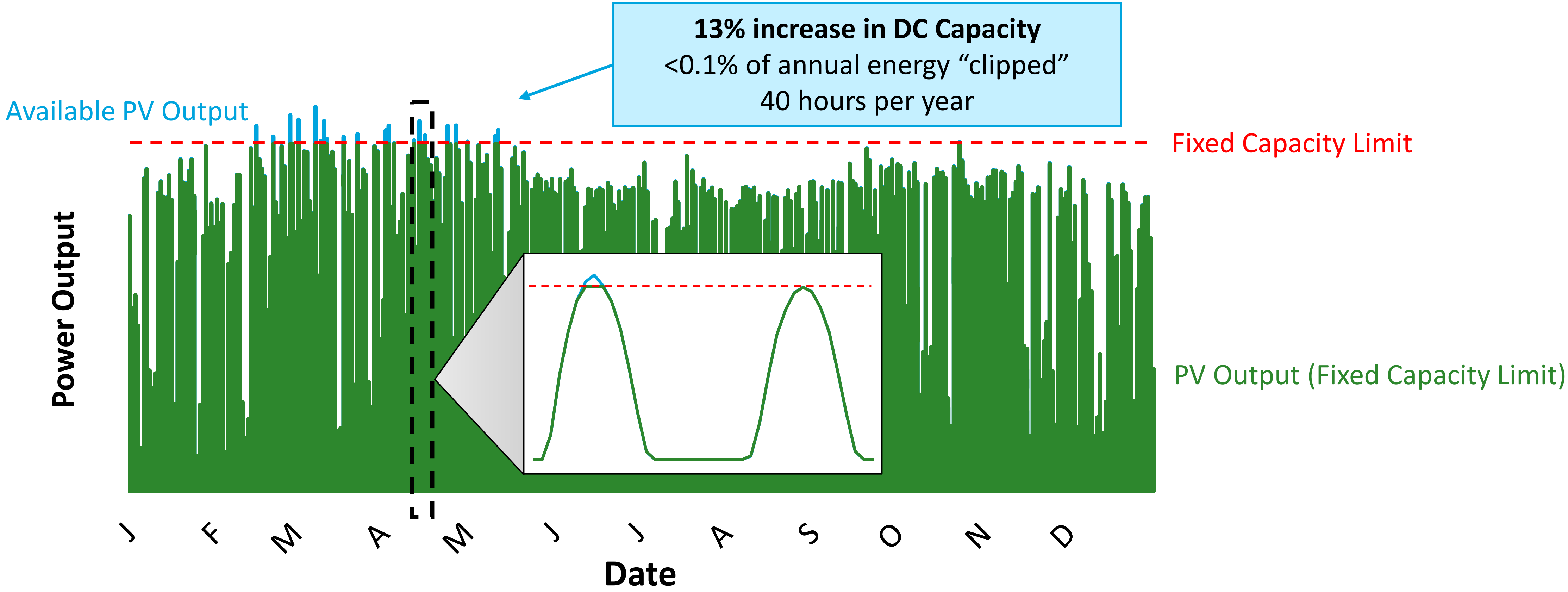
Rule 21 Ph 3 Fxns. when Managed





Flexibility Enabled by Rule 21 Ph 3 Functions

Optimal PV system designs already curtail available solar energy



Typical PV system designs limit ("clip") available solar energy based on fixed capacity limits. Curtailment IS Cost-Effective for PV Plant Developers

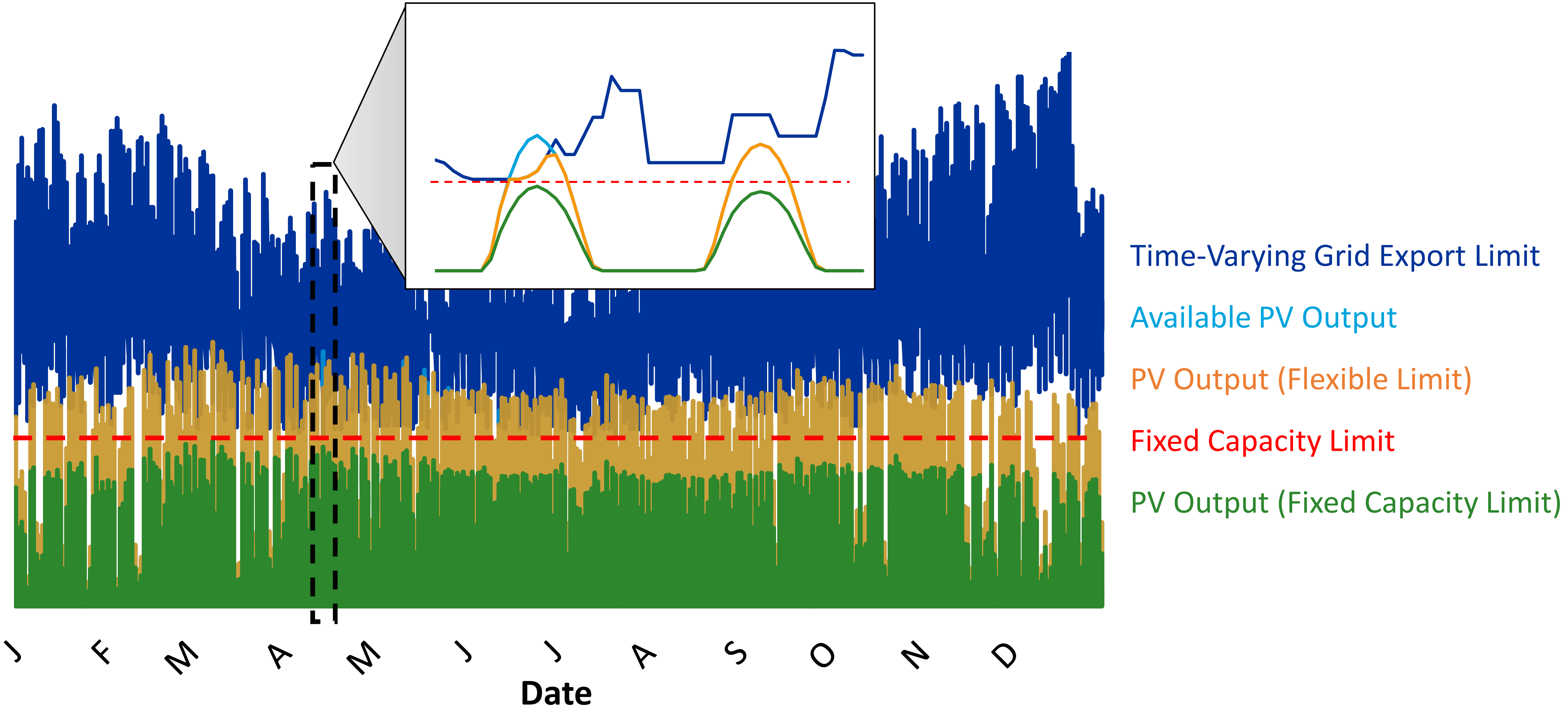
Recognizing Time-Varying Grid Constraints

Should feeder capacity be expanded to be used only a few hours per year?

60% increase in PV capacity

<0.1% energy curtailment

<20 hours per year



__Takeaway__: Curtailment can be a low cost integration solution.

Rule 21 Ph 3 Sets-the-stage for Flexible Interconnections

[What is Flexible I/C ?](#) *Offer DER customers **faster** and **cheaper** interconnection to integrate **more DER** in areas with limited hosting capacity*

Drivers

- Low resource costs
  - i.e. cheap/available land
- Expensive grid-side mitigation measures
- Infrequent need to curtail

Example Use Case:

- *Avoid construction of dedicated feeders*

Benefits

- **DER customers:** faster, cheaper connection; can be temporary
- **Ratepayers:** reduce socialized portion of upgrade costs; improved network utilization
- **Policy objectives:** Accelerate progress towards DER penetration goals and/or emissions targets

Together…Shaping the Future of Electricity

RATES

A Complete and Low-Cost
Retail Automated Transactive Energy System

Reduce Costs of Meeting California's 2045 100% Clean Energy, Electrification, and GHG Goals
by
Enabling Retail Customers to Self-Manage, Shape, and Shift Electricity Use, Storage, and Supply
so that
Net Electricity Usage Better Follows Variable Solar & Wind Generation
using
IoT + Subscription Transactive Tariffs + Transactive Energy Platforms

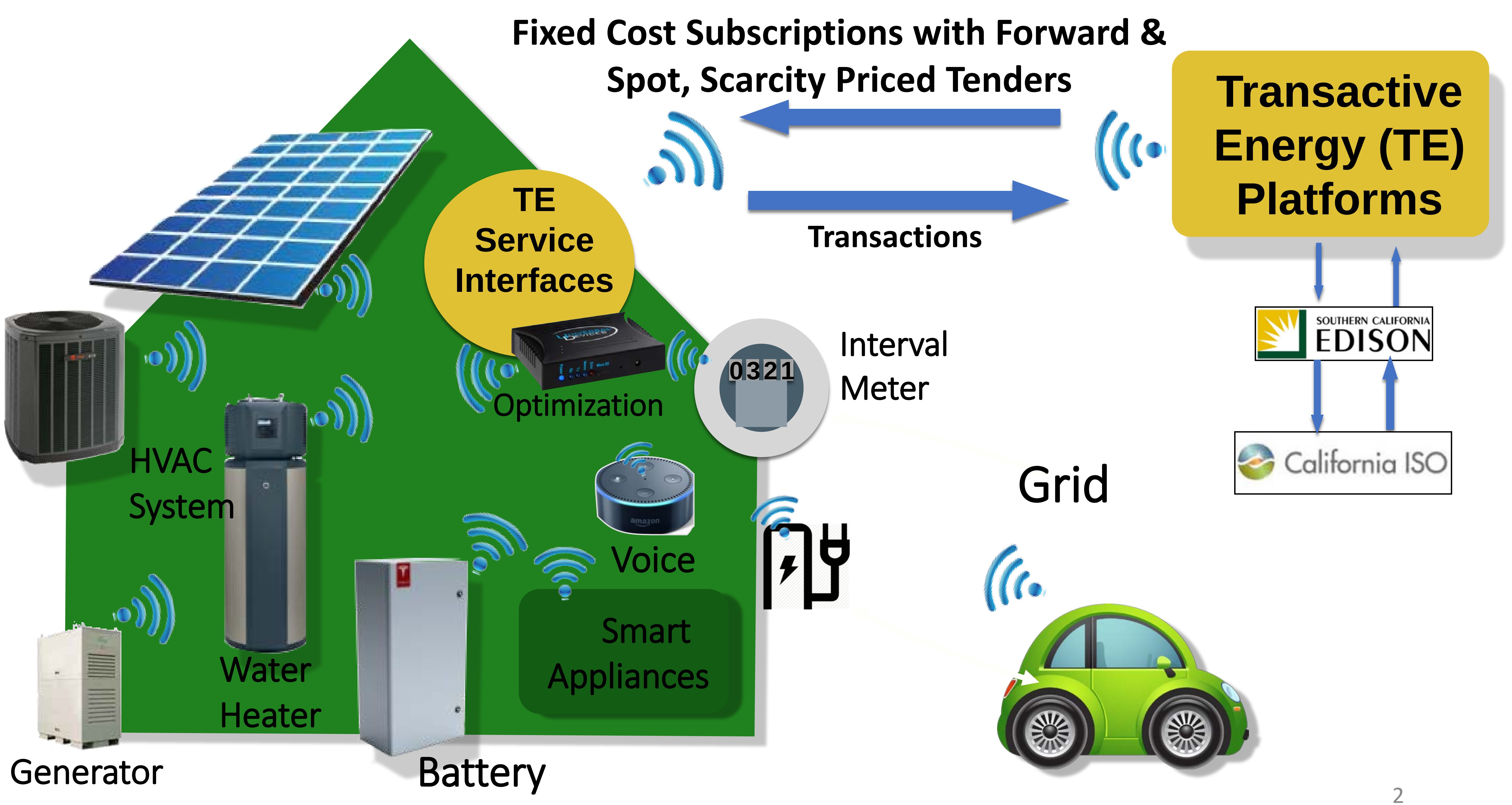
FUNDING PROVIDED BY THE CALIFORNIA ENERGY COMMISSION

GFO 15-311 / Group 2

Universal Devices

TeMix Transactive Energy Services

- Fixed Cost Subscriptions Stabilize Customer Electric Bills
- Variable Buy and Sell Prices Enable Self-Management

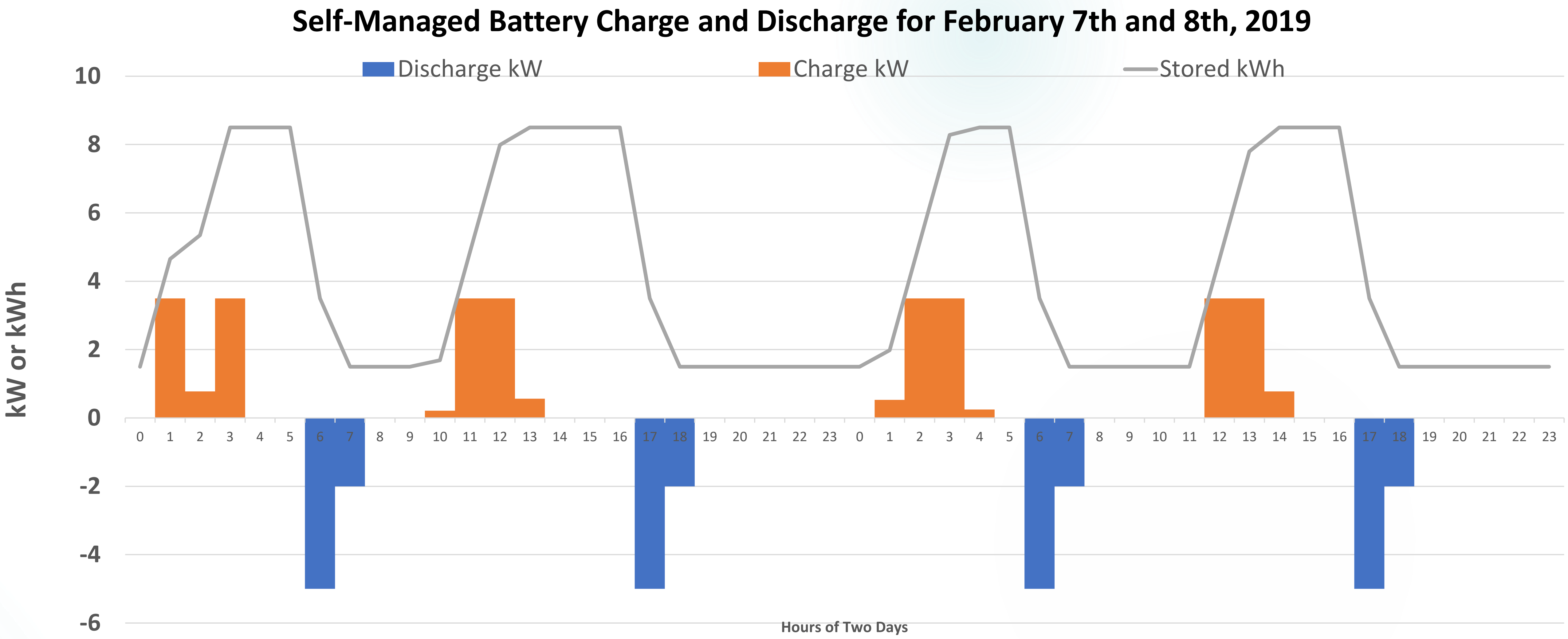


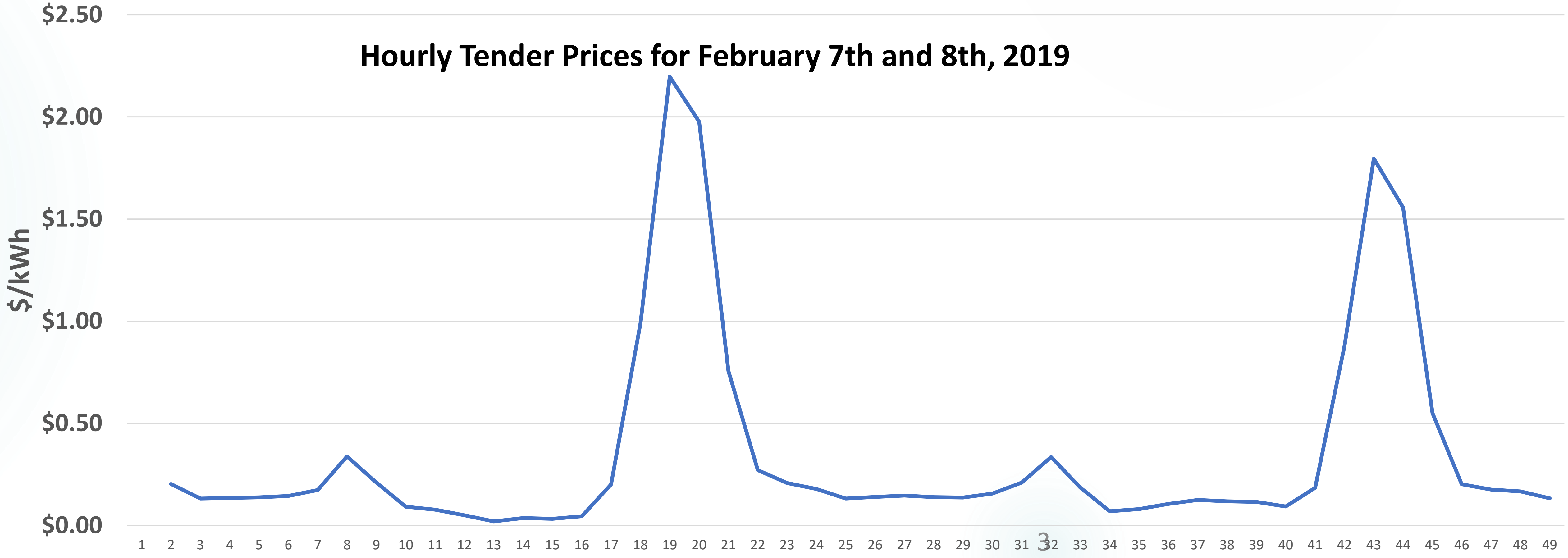
RATES Customer Battery Example

Battery Specifications:
9.8 kWh Storage Capacity
8.5 kWh Maximum Storage
1.5 kWh Minimum Storage
5 kW Maximum Discharge Rate
3.5 kW Maximum Charge Rate
90% Round Trip Efficiency

Operating Results:
14 kWh / Day Discharge
15.56 kWh/ Day Charge

$17.00 First Day Net Revenues
$13.50 Second Day Net Revenues





Smart Inverter Interoperability Standards and Open Testing Framework to Support High-Penetration Distributed Photovoltaics and Storage

Summary of EPC 14-303

February 19, 2019

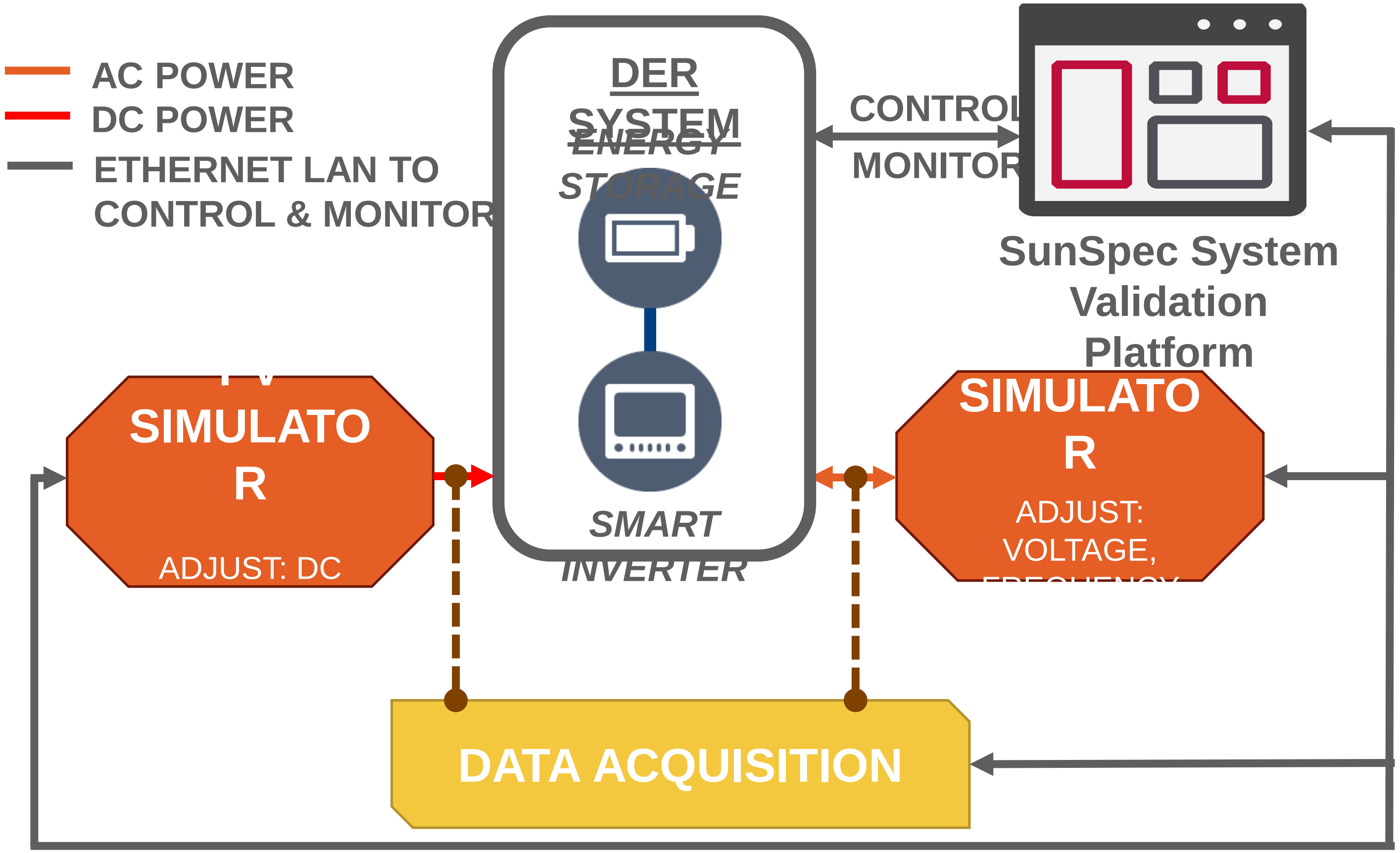
Program Objectives

- Deliver a test & certification framework for CA Rule 21 compliance
- Reduce DER system engineering costs by 10%
- Demonstrate safe DER penetration on feeder circuits above the IEEE-mandated 15% limit using communication and smart inverters
- Demonstrate the ability of smart inverters to support the power grid during system disturbances and increase power grid reliability
- Identify new revenue models for DER investors and operators

SunSpec Open Source Reference Test Platform

Test Capability

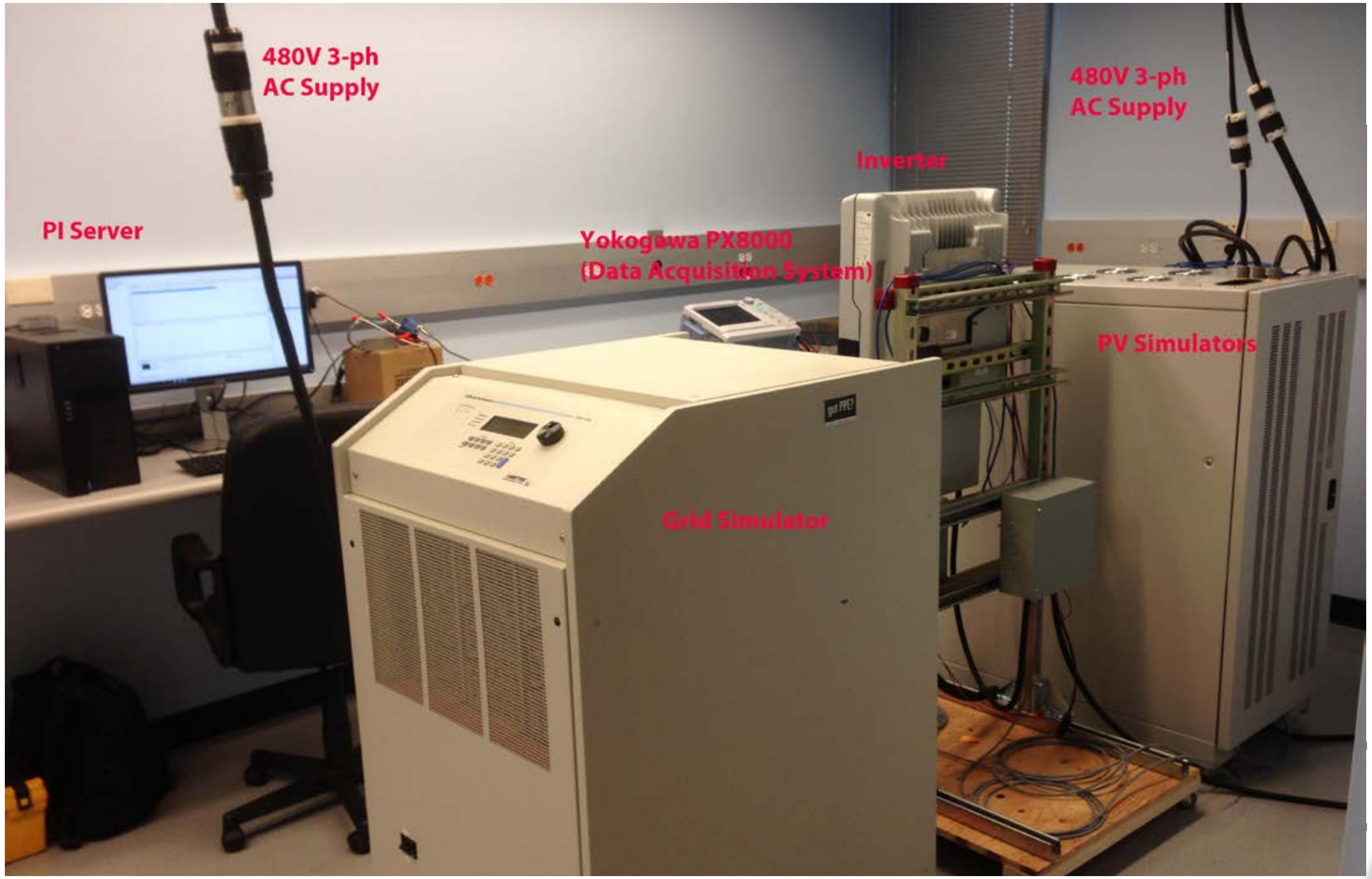
- Advanced inverter and storage
- SunSpec Modbus
- IEEE 2030.5*



* Available Q1 2019

SunSpec Open Source Reference Test Platform At UCSD

- Five manufacturers proven CA Rule 21 compliant
- Standard communication interface enables CA Rule 21 Phase 1 remote settings



IEEE 2030.5/CSIP Enhances Grid Stability

- 15 PV+storage systems networked with IEEE 2030.5/CSIP
- Demonstrated CA Rule 21 Phase 1 settings changes alleviate grid issues

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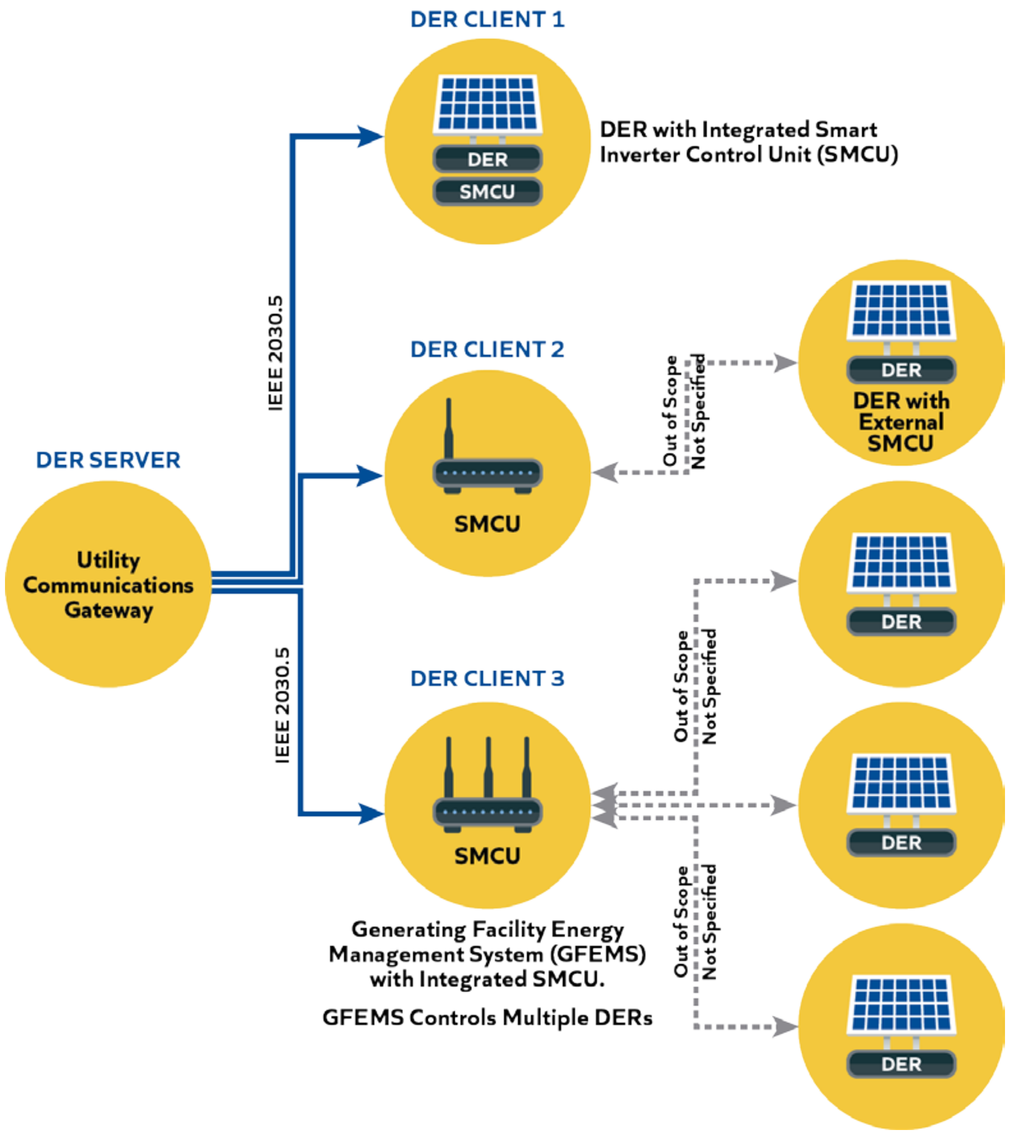
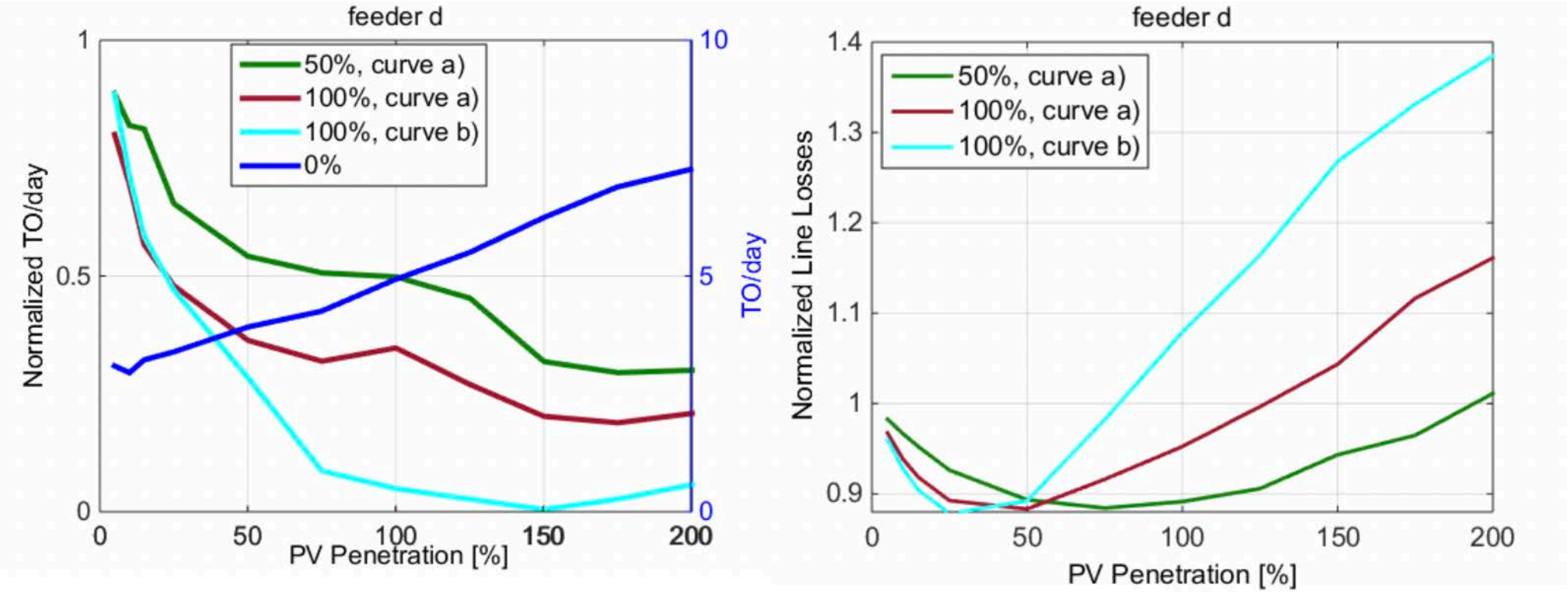
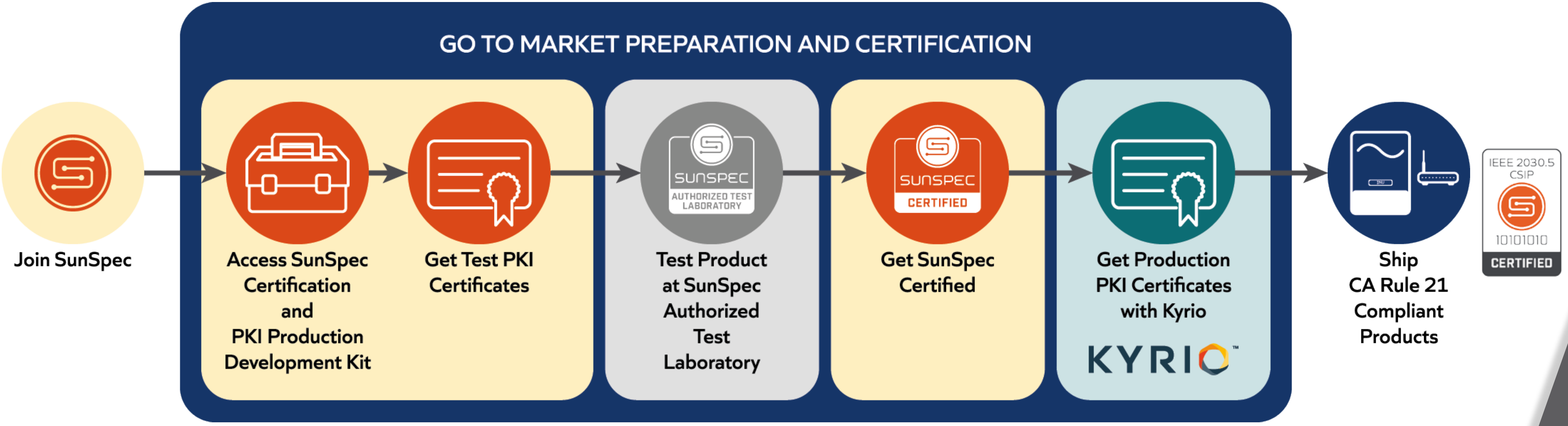


DER Circuit Penetration: Safe At 100%



ES 2: Normalized tap operation (left) and line losses (right) as a function of increasing PV penetration. The left image has two y axis. The right axis represents the average tap operations per day of the feeder with increasing PV penetrations. The left axis represents normalized tap operations of the feeder in the presence of SI.

Cost Efficiency From Standardization



- Standard communication interface eliminates network integration cost
- Standard PKI ensures uniform, low-cost cybersecurity solutions

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